CLAIMS

What is claimed is:

1. A method for registering two-dimensional image data with three-dimensional image data of a body of interest, said method comprising:

acquiring the three-dimensional image data having first patient orientation information;

acquiring the two-dimensional image data having second patient orientation information; and

generating a digitally reconstructed radiograph that substantially corresponds to the two-dimensional image data using the three-dimensional image data and the first and second patient orientation information.

2. The method as defined in Claim 1 wherein acquiring two-dimensional image data further includes acquiring a two-dimensional anterior to posterior image and a two-dimensional lateral image.

3. The method as defined in Claim 2 further comprising identifying a center of a body of interest in the two-dimensional anterior to posterior image and the two-dimensional lateral image.

4. The method as defined in Claim 3 wherein generating a digitally reconstructed radiograph further includes generating an anterior to posterior digitally reconstructed radiograph and a lateral digitally reconstructed radiograph corresponding to the two-dimensional anterior to posterior image and the two-dimensional lateral image.

5. The method as defined in Claim 4 further comprising identifying a center of the body of interest in the anterior to posterior digitally reconstructed radiograph and the lateral digitally reconstructed radiograph.

6. The method as defined in Claim 5 further comprising identifying a common point in the three-dimensional image data with the two-dimensional image data using the identified centers of the anterior to posterior image, lateral image, anterior to posterior digitally reconstructed radiograph image and lateral digitally reconstructed radiograph image.

7. The method as defined in Claim 6 further comprising refining the registration of the two-dimensional image data with the three-dimensional image data using the first and second patient orientation information and the common point information.

8. The method as defined in Claim 7 wherein the refined registration employs at least two similarity/cost measures selected from a group of at least a normalized mutual information algorithm, a mutual information algorithm, a gradient difference algorithm, a gradient algorithm, a line contour algorithm, a surface contour algorithm, a pattern intensity algorithm or a combination thereof.

9. The method as defined in Claim 8 further comprising optimizing the selected similarity/cost measures using an optimization algorithm selected from a group of at least a multi-stage steepest ascent algorithm, a steepest ascent algorithm, a gradient-based optimization algorithm or a combination thereof.

10. The method as defined in Claim 7 further comprising adjusting a registration window on the body of interest in each anterior to posterior image, lateral image, anterior to posterior digitally reconstructed radiograph image, and lateral digitally reconstructed radiograph image, wherein only the image data within the registration windows are used for refined registration.

11. The method as defined in Claim 9 further comprising verifying the refined registration for accuracy by selecting a point in the three-dimensional image data to confirm its accuracy with a point in the two-dimensional image data.

12. The method as defined in Claim 1 further comprising performing a refinement registration utilizing normalized mutual information and pattern intensity.

13. The method as defined in Claim 12 further comprising optimizing the refinement registration by utilizing a multi-stage steepest ascent algorithm.

14. The method as defined in Claim 1 further comprising performing multiple registrations on multiple bodies of interest.

15. The method as defined in Claim 1 wherein the body of interest is a vertebrae.

16. A method for registering two-dimensional image data with three-dimensional image data of a body of interest, said method comprising:

acquiring the three-dimensional image data;

acquiring the two-dimensional image data;

generating a digitally reconstructed radiograph using the three-dimensional image data; and

registering the two-dimensional image data with a three-dimensional image data using a first similarity/cost measure and a second similarity/cost measure.

17. The method as defined in Claim 16 wherein registering the two-dimensional image data with the three-dimensional image data further includes minimizing the difference between the digitally reconstructed radiograph and the two-dimensional image data.

18. The method as defined in Claim 16 further comprising optimizing the first similarity/cost measure and the second similarity/cost measure.

19. The method as defined in Claim 16 wherein the first similarity/cost measure is normalized mutual information and the second similarity/cost measure is pattern intensity.

20. The method as defined in Claim 19 further comprising optimizing the normalized mutual information and the pattern intensity utilizing a multi-stage steepest ascent algorithm.

21. The method as defined in Claim 16 further comprising verifying registration accuracy.

22. The method as defined in Claim 16 further comprising adjusting a registration window in the two-dimensional image data and a registration window in the digitally reconstructed radiograph where the image data within the registration windows are used for registration.

23. The method as defined in Claim 16 wherein acquiring three-dimensional image data further includes acquiring three-dimensional image data having first patient orientation information and wherein acquiring two-dimensional image data further includes acquiring two-dimensional image data having second patient orientation information and wherein generating the digitally reconstructed radiograph further includes using the first and second patient orientation information.

24. The method as defined in Claim 16 further comprising performing intensity adjustment on the two-dimensional image data.

25. The method as defined in Claim 24 wherein performing intensity adjustment on the two-dimensional image data includes performing intensity adjustment on a two-dimensional lateral image of the body of interest, wherein generating a digitally reconstructed radiograph further includes generating a lateral digitally reconstructed radiograph that substantially corresponds to the two-dimensional lateral image.

26. The method as defined in Claim 25 further comprising aligning the two-dimensional lateral image with the lateral digitally reconstructed radiograph utilizing at least one similarity/cost measure.

27. The method as defined in Claim 26 wherein the similarity/cost measure is normalized mutual information.

28. A method for registering two-dimensional image data with three-dimensional image data of a body of interest, said method comprising:

acquiring the three-dimensional image data of the body of interest;

acquiring a two-dimensional image of the body of interest;

generating a digitally reconstructed radiograph that substantially corresponds to the two-dimensional image;

performing intensity adjustment of the two-dimensional image to reduce the effect of an interfering object; and

aligning the two-dimensional image with the digitally reconstructed radiograph using a similarity/cost measure.

29. The method as defined in Claim 28 wherein the two-dimensional image of the body of interest is a two-dimensional lateral image.

30. The method as defined in Claim 29 further comprising acquiring a two-dimensional anterior to posterior image and generating an anterior to posterior digitally reconstructed radiograph that substantially corresponds to the anterior to posterior image.

31. The method as defined in Claim 30 further comprising registering the two-dimensional lateral image and the two-dimensional anterior to posterior image with the three-dimensional image data using a first similarity/cost measure and a second similarity/cost measure.

32. The method as defined in Claim 30 wherein acquiring the three-dimensional image data further includes acquiring first patient orientation information, wherein acquiring the two-dimensional lateral image and the two-dimensional anterior to posterior image further includes acquiring second patient orientation information, and wherein generating the digitally reconstructed radiographs further includes generating the lateral digitally reconstructed radiograph and the anterior to posterior digitally reconstructed radiograph using the three-dimensional image data and the first and second patient orientation information.

33. The method as defined in Claim 32 further comprising identifying a center of the body of interest in the two-dimensional anterior to posterior image and the two-dimensional lateral image.

34. The method as defined in Claim 33 further comprising identifying a center of the body of interest in the anterior to posterior digitally reconstructed radiograph and the lateral digitally reconstructed radiograph.

35. The method as defined in Claim 34 further comprising identifying a common point in the three-dimensional image data with the two-dimensional image data using the identified centers of the anterior to posterior image, lateral image, anterior to posterior digitally reconstructed radiograph image and lateral digitally reconstructed radiograph image.

36. The method as defined in Claim 31 further comprising optimizing the first and second similarity/cost measures using an optimization algorithm.

37. A method for registering two-dimensional image data with three-dimensional image data of a body of interest, said method comprising:

acquiring the three-dimensional image data having first patient orientation information;

acquiring a first two-dimensional image having second patient orientation information;

acquiring a second two-dimensional image having third patient orientation information;

identifying a center of the body of interest in the first and second images;

generating first and second digitally reconstructed radiographs;

identifying the center of the body of interest in the first and second digitally reconstructed radiographs; and

registering the first and second two-dimensional images with the three-dimensional image data using at least a first similarity/cost measure and a second similarity/cost measure.

38. The method as defined in Claim 37 wherein said first two-dimensional image is a first two-dimensional anterior to posterior image and said second two-dimensional image is a second two-dimensional lateral image.

39. The method as defined in Claim 38 further comprising performing intensity adjustment on the two-dimensional lateral image and aligning the two-dimensional lateral image with the lateral digitally reconstructed radiograph.

40. The method as defined in Claim 37 wherein the first similarity/cost measure is normalized mutual information and the second similarity/cost measure is pattern intensity.

41. The method as defined in Claim 37 further comprising optimizing the first and second similarity/cost measures.

42. The method as defined in Claim 41 wherein first and second similarity/cost measures are optimized using a multi-stage steepest ascent algorithm.